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Factors affecting the accuracy of estimated fetal weight in small for gestational age (SGA) fetuses

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ABSTRACT

Aims: To identify factors influencing the accuracy of estimated fetal weight in small for gestational age (SGA) fetuses.

Methods: This retrospective cohort study included 268 women in the third trimester with singleton pregnancies and estimated fetal weight below the 10th percentile. Data were obtained from electronic medical records, and the Hadlock formula was used to estimate fetal weight through ultrasound measurements. Patients with fetal growth restriction due to placental insufficiency, preeclampsia, multiple pregnancies, or fetal anomalies were excluded from the study. The study groups were categorized based on differences between their estimated and actual birth weights.

Results: The analysis showed that 24.3% of the cases had a difference of >10% between estimated and actual birth weights. The mode of delivery was significantly associated with weight difference, with a lower cesarean section rate in the group with a difference >10%. There were no significant differences in clinical and sonographic characteristics between the study groups. Perinatal outcomes did not exhibit significant differences in gestational age at delivery, delivery mode, sex, or meconium-stained amniotic fluid. However, there was a significant difference in birth weight, with higher birth weights observed in the group with a difference >10%. Logistic regression analysis did not reveal any statistically significant associations between the examined factors and weight differences >10%.

Conclusion: This study highlights the challenges of accurately estimating fetal weight in SGA fetuses. Further research is needed to identify additional factors and develop more reliable methods for estimating fetal weight in these cases, aiming to improve prenatal management and reduce the risk of adverse outcomes.

Keywords: Fetal weight estimation, small gestational age (SGA), discrepancy, estimated fetal weight, gestational age

INTRODUCTION

Accurate estimation of fetal weight is essential for monitoring fetal growth and ensuring appropriate obstetric management.[1] One important subset of fetuses that require careful monitoring are those with an estimated fetal weight below the 10th percentile for gestational age (SGA). These fetuses, although small, may be small for gestational age (SGA) rather than growth-restricted, meaning they are small but otherwise healthy.

It is crucial to differentiate between SGA and those with fetal growth restriction (FGR). While SGA fetuses are small due to genetic and familial factors, FGR indicates a pathological condition where the fetus is not growing at a normal rate due to underlying issues such as placental insufficiency or maternal health problems.[2] This study focuses on fetuses that are estimated to be SGA, without evidence of FGR.

Accurate estimation of fetal weight in these SGA is particularly challenging due to the variability in growth patterns and the potential for underlying health issues to affect measurements. Discrepancies between estimated fetal weight (EFW) and actual birth weight can complicate clinical decision-making and impact the management of pregnancies identified as high-risk. Understanding the factors influencing the accuracy of the estimated fetal weight in these fetuses can help improve prenatal management and potentially reduce the risk of adverse outcomes.

Previous studies have indicated challenges in accurately estimating fetal weight in SGA. For example, Cooper et al.[3] reported that estimated fetal weights were more frequently inaccurate at extremes of fetal weight. Stephens et al.[4] found

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that ultrasound estimation of birth weight in small fetuses tended to overestimate birth weight, possibly due to a decrease in fetal weight near delivery. Bardin et al.[5] highlighted that various clinical and ultrasonographic factors influence the accuracy of ultrasound-estimated fetal weight in predicting small size and macrosomia.

This retrospective cohort study aims to identify the factors influencing the accuracy of estimated fetal weight in SGA fetuses. By understanding these factors, we hope to improve prenatal management strategies and reduce the risk of adverse outcomes associated with inaccurate fetal weight estimation.

METHODS

This retrospective cohort study was conducted at a tertiary referral center. This study included 268 women in the third trimester with singleton pregnancies who were referred to the perinatology department between January 2022 and January 2023. Approval for this study was obtained from Başakşehir Çam and Sakura Hospital Clinical Researches Ethics Committee (Date: 24.11.2022, Decision No: KAEK/2022.11.354). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Patients were initially referred from routine antenatal care clinics due to suspicion of fetal growth restriction, specifically when the fetal abdominal circumference was below the 10th percentile. Upon referral to the perinatology department, these cases were further evaluated to differentiate between SGA fetuses and those with FGR.

The study included singleton pregnancies with an estimated fetal weight <10th percentile, normal fetal Doppler findings, and no fetal anatomical abnormalities. Patients were excluded if they had fetal growth restriction owing to placental insufficiency, preeclampsia, chronic maternal disease, multiple pregnancies, or fetal anomalies. We also reviewed the medical history of all eligible patients, including previous pregnancy outcomes and high-risk pregnancies. This information was used to ensure a comprehensive understanding of each case, although it did not form part of the exclusion criteria, unless it coincided with the aforementioned exclusion factors.

Data were obtained from electronic medical records of pregnant women who received prenatal care and delivered at a large tertiary care hospital. The gestational age during sonographic evaluation was determined using either the last menstrual period or first-trimester ultrasound results. Ultrasonography was performed within three days before delivery, and the Hadlock formula, which incorporates nationally accepted standard fetal biometry measurements, was used to calculate the estimated fetal weight. Measurements of biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL) were used to calculate estimated fetal weight using the Hadlock formula.[1]

The following data were collected for each case: maternal age, maternal body-mass index (BMI), parity, previous delivery mode, oligohydramnios, placental location, uterine notch, fetal presentation, fetal movements, fetal sex, estimated fetal weight at the time of ultrasound examination indicating SGA status (below the 10th percentile), and actual birth weight.

The cases were divided into two groups based on the difference between the estimated fetal and actual birth weights. A 10% cutoff was chosen based on previous literature suggesting that differences greater than 10% are clinically significant and may impact obstetric decision making.[6,7] The relative percentage difference was calculated using the following formula: relative difference %=[(EFW birth weight)/birth weight]×100. While we considered using a 5% cutoff, the 10% threshold was chosen to align with the existing literature and account for the inherent variability in ultrasound measurements, especially in the context of SGA fetuses. This decision allows for a more robust classification of significant discrepancies, while minimizing the potential for overclassification owing to minor measurement variations.

Statistical Analysis

Demographics and ultrasound data are presented as medians (interquartile ranges) and numbers (percentages). All statistical analyses were performed using IBM SPSS version 26 (IBM, Armonk, NY, USA), and p<0.05. The normality of the numerical data was examined using the Kolmogorov-Smirnov test. Comparisons between the study groups were made using the Mann–Whitney U test for continuous variables and the chi-square test for categorical variables. Multivariate analysis was conducted using logistic regression, with stepwise inclusion of variables that had the strongest associations with the outcome of interest. This analysis determined the odds ratio (OR) and 95% confidence interval (CI) of each variable.

RESULTS

The study was completed by 268 participants. The difference between birth weight and estimated fetal weight was less than 10% in 203 (75.7%) cases. In comparison, in 65 (24.3%) cases, birth weight was overestimated or underestimated by >10% on ultrasound. Of the 65 cases in which the difference between birth weight and estimated fetal weight was >10%, birth weight was >10% higher than the estimated fetal weight in 49 cases and less than 10% lower in 16 cases. The ultrasound delivery interval was within three days in all cases.

Table 1 presents the selected clinical characteristics, including age, BMI, gravidity, parity, and delivery mode, of the participants with or without a difference of >10% percentile. There were no significant differences between the study groups in terms of maternal age, BMI, gravidity, and parity (p>0.05). Regarding the mode of delivery, the cesarean section rate was significantly lower in the group, with a difference of >10% (p<0.05).

Table 2 presents the selected sonographic characteristics of participants with and without a difference in the >10% percentile. There was no significant difference between the study groups in terms of gestational age, placental location, oligohydramnios, presence of uterine notch, fetal presentation, or fetal movement counting (p>0.05).

Table 3 presents the perinatal outcomes of participants with and without a difference in the >10% percentile. There were no significant differences between the study groups in terms of gestational age, delivery mode, sex, or meconium-stained amniotic fluid (p>0.05). However, birth weight was significantly different between the groups (p<0.01).

Table 1. Clinical characteristics of study groups according to a cutoff of 10% difference between estimated fetal and birth weights

	Difference ≤10% (n=203)	Difference >10% (n=65)	
Age (years)	27 (18-43)	26 (19-43)	0.37
Body-mass index (kg/m²)	27.5 (17.3-44.2)	27.7 (20.4-34.9)	0.47
Gravidity	2 (1-9)	2 (1-4)	0.73
Parity	0 (0-3)	0 (0-3)	0.76
Mode of delivery			
Nulliparous	103 (50.7%)	34 (52.3%)	0.011
Multiparous	100 (49.3%)	31 (47.7%)	
Vaginal	34 (16.7)	20 (30.8%)	
Cesarean section	66 (32.6)	11 (16.9%)a	

Data were expressed as the median with min-max values and count (%). Regarding the mode of delivery of participants, the cesarean section rate was significantly lower in the group, with a difference of >10% (p<0.05)

Table 2. Sonographic characteristics of study groups according to a cutoff of 10% difference between estimated fetal and birth weights

	Difference ≤10% (n=203)	Difference >10% (n=65)	
Gestational age at ultrasound scan	37 (36-38)	37 (36-38)	0.42
Placental location			
Fundal	22 (10.8)	9 (13.8%)	0.621
Anterior	89 (43.8%)	23 (35.4%)	
Posterior	60 (29.6%)	23 (35.4%)	
Other	32 (15.8%9)	10 (15.4%)	
Oligohydramnios			
Yes	35 (17.2%)	19 (29.2%)	0.36
No	168 (82.8%)	46 (70.8%)	
Uterine notch			
Absent	186 (91.6%)	59 (90.8%)	0.516
Unilateral	14 (6.9%)	6 (9.2%)	
Bilateral	3 (1.5%)	0 (0%)	
Fetal presentation			
Cephalic	182 (89.7%)	61 (93.8)	0.312
Non-cephalic	21 (10.3%)	4 (6.2%)	
Estimated fetal weight	2385 (2008-2766)	2315 (2023-2800)	0.17
Fetal movements			
Normal	198 (97.5%)	59 (90.8%)	0.17
Decreased	5 (2.5%)	6 (9.2%)	

Data were given as median (min-max) or count (%)

Table 3. Perinatal outcomes of study groups according to a cutoff of 10% difference between estimated fetal and birth weights

	Difference ≤10% (n=203)	Difference >10% (n=65)	
Gestational age at delivery (weeks)	37 (36-38)	37 (36-38)	0.73
Mode of delivery			
Vaginal	66 (32.5%)	26 (40%)	0.268
Cesarean section	137 (67.5)	39 (60%)	
Birth weight (g)	2400 (1910-2850)	2500 (2010-3080)	0.002
Gender			
Male	88 (43.3%)	29 (44.6%)	0.858
Female	115 (56.7%)	36 (55.4%)	
Meconium-stained amniotic fluid			
Yes	27 (13.3)	6 (9.2)	0.385
No	176 (86.7)	59 (90.8)	

Data were given as median (min-max) or count (%)

Table 4 displays the odds ratio values of the study groups with and without a difference in the >10% percentile. Logistic regression analysis was conducted to determine the factors that could potentially cause the difference between birth weight and estimated fetal weight to be greater than 10 percent. The analysis included BMI, oligohydramnios, placental location, fetal movement, mode of delivery, and uterine notch. The results showed that none of the examined factors had a statistically significant association with weight differences exceeding 10%. Although oligohydramnios (p=0.041) and fetal movements (p=0.052) showed p-values close to the conventional significance threshold of 0.05, they did not reach statistical significance when considering the multiple comparisons performed in this analysis.

Table 4. Odds ratio values of the study groups with or without the difference of >10% percentile

	Odds ratio (CI 95%)	p value
Body-mass index (kg/m²)	1.010	0.796
Oligohydramnios	0.492	0.041
Placental location	1.262	0.676
Fetal movements	0.284	0.052
Mode of delivery	1.038	0.900
Uterine notch	0.703	0.953

DISCUSSION

Accurately estimating fetal weight is crucial for appropriate obstetric management and predicting adverse outcomes. This retrospective cohort study investigated the factors affecting the accuracy of estimated fetal weight in small for SGA fetuses. The results revealed a discrepancy between the estimated fetal and actual birth weights in many cases, highlighting the challenges of accurate estimation. Approximately 24.3% of the cases had a difference of >10% between the estimated and actual weights.

The clinical characteristics analyzed, including maternal age, BMI, gravidity, and parity, did not show significant differences between the study groups. This suggests that these factors may not significantly influence the accuracy of the estimated fetal weight in SGA fetuses. However, the mode of delivery was significantly associated with weight difference, with a lower cesarean section rate in the group with a difference of >10%. Sonographic characteristics, such as gestational age, placental location, oligohydramnios, uterine notch, fetal presentation, and fetal movement counting also did not show significant differences between the study groups, indicating that these parameters may not reliably predict the accuracy of the estimated fetal weight in fetuses with SGA. Analysis of perinatal outcomes showed no significant differences in gestational age at delivery, mode of delivery, sex, or meconium-stained amniotic fluid between the study groups. However, a significant difference was observed in birth weight, with the group with a difference of >10% showing higher birth weights. This finding suggests that inaccurate estimation of fetal weight in fetuses with SGA can lead to deviations from the expected birth weight. Logistic regression analysis did not identify any significant associations between BMI, oligohydramnios, placental location, fetal movements, mode of delivery, uterine notch, and weight differences.

Logistic regression analysis did not identify any statistically significant associations between the examined factors (including BMI, oligohydramnios, placental location, fetal movements, mode of delivery, and uterine notch) and weight differences exceeding 10%. Notably, oligohydramnios (p=0.041) and fetal movements (p=0.052) showed p-values close to the conventional significance threshold of 0.05. However, these results should be interpreted cautiously because of the multiple comparisons performed and relatively small sample size. Further studies with larger sample sizes are needed to definitively determine the role of these factors in weight estimation discrepancies in SGA fetuses.

These findings underscore the challenges of accurately estimating fetal weight in fetuses with SGA. Further research is needed to identify additional factors that may influence the accuracy of estimated fetal weight fetuses with an estimated fetal weight below the 10th percentile, and to develop more reliable methods for estimating fetal weight in these cases.

Our study aligns with previous findings that highlight the difficulty of accurate weight estimation fetuses with an estimated fetal weight below the 10th percentile. Studies found that EFW often overestimated birth weight (BW) in SGA infants, with a mean percentage difference of 16.2% compared with 6.9% in appropriate for gestational age (AGA) infants.[8,9] This overestimation in SGA infants underscores the need for cautious interpretation of EFW, as it may lead to overestimation of fetal health and underestimation of potential risks.

Moreover, maternal BMI has been shown to significantly affect the accuracy of fetal weight estimation. Sgayer et al.[7] reported that the accuracy of EFW was lower in obese women compared to those with a normal BMI. This finding suggests that maternal BMI should be considered when interpreting ultrasound results to improve the accuracy of fetal weight estimates.

Additionally, advancements in machine learning, such as deep learning-based models, have demonstrated improved accuracy in fetal weight estimation compared to traditional methods such as Hadlock's formula.[9] These models utilize advanced algorithms to provide more precise estimates, which are crucial for clinical decision making. Accurate fetal weight estimation helps to distinguish between SGA fetuses and those with FGR, ensuring appropriate monitoring and intervention strategies.[11]

Furthermore, a study by Benson-Cooper et al.[3] indicated that ultrasound tended to overestimate the weight of SGA fetuses and underestimate the birth weights of large for gestational age (LGA) fetuses. They also noted that a higher maternal BMI was associated with a greater likelihood of underestimating fetal weight, emphasizing the need for careful consideration of maternal characteristics when interpreting ultrasound estimates.

Limitations

Our study had several limitations. The retrospective design may introduce selection bias, and the study was conducted at a single tertiary referral center, which may limit the generalizability of the findings. Additionally, the sample size, while providing valuable insights, may need to be larger to detect smaller differences and to validate the findings in different populations. Operator variability in ultrasound measurements and focusing only on specific clinical and sonographic characteristics without considering other potential influencing factors such as maternal nutrition, genetic factors, and environmental influences are other limitations. Finally, ultrasound measurements taken within three days before delivery may not account for rapid changes in fetal weight in the late stages of pregnancy.

CONCLUSION

In conclusion, the accurate estimation of fetal weight in SGA fetuses remains challenging. Our study identified factors such as mode of delivery and birth weight differences. However, further research is necessary to better understand and improve the accuracy of the estimated fetal weight in these cases.

ETHICAL DECLARATIONS

Ethics Committee Approval

Approval for this study was obtained from Başakşehir Çam and Sakura Hospital Clinical Researches Ethics Committee (Date: 24.11.2022, Decision No: KAEK/2022.11.354).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process
Externally peer-reviewed.

Conflict of Interest Statement
The authors have no conflicts of interest to declare.

Financial Disclosure
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Author Contributions
All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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